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April 19, 2017

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1051 Boston Post Road
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Dear Attorney Wilson:

The City of Rye New York, through your office, has requested that the undersigned a New York State Licensed Professional Engineer specializing in Radio Frequency Engineering review portions and provide a second opinion on the request by Crown Castle East Coast NG ("Crown Castle"), ("Applicant") to construct a 64 Node Distributed Antenna System ("DAS") on existing utility poles in the city This response focused on what would be required if Chapter 196 applied, and Crown Castle (or Verizon Wireless) were required to show that the proposed installation is necessary. However, the observations as to what is proven, network standards, and the like may also be relevant to the City's considerations of whether the request for placement should be approved under the Right of Way Use Agreement, assuming that, and not Chapter 196,applies, and may also be relevant to its consideration of issues under SEQRA.

For this review, which is limited to specific issues associated with radio frequency propagation and the need for radio frequency coverage or capacity of Cellular, PCS or AWS systems, the undersigned utilized the following submissions from the Applicant along with other information available from reliable sources or data bases assessable by utilizing assets on the internet.

RF Design Criteria Supplement, dated December 1, 2016, prepared by Gregory Sharpe, Senior Radio Frequency Engineer, Crown Castle. ("Report 1")

Crown's Expansion of an Existing DAS System in the City of Rye, Dated April 7, 2017, prepared by Ali Aljibori, Radio Frequency Engineer, Verizon Wireless. (Report 2")

Crown Castle City of Rye Drive Tests, dated October 19, 2016, author unknown (Report 3)

Satellite imagery provided by Bing Maps

Verizon Wireless Reports prepared for public hearings for the siting of Wireless Telecommunications Facilities that are in the Public Domain

Mr. Sharpe in Report 1 states that it is a justification to construct a DAS system to provide 2100 MHz coverage at -85 dBm RSRP (Reference Signal Received Power) in the City of Rye. He notes that the plan calls for the deployment of 20 MHz of 2100 MHz AWS Band and 20 MHz of PCS Band. So as to support his claim for the need of the system to provide coverage for Verizon Wireless he presents a map entitled Crown Castle Current Coverage in City of Rye. This map purports to present the results of actual drive tests of the existing Verizon Wireless system at 2100 MHz There are, however, a number of issues associated with the map that make it somewhat difficult to provide a critical analysis. The map appears to cut off portions of the city to the west. The map fails to have a scale indicating miles per inch or some other unit of measure. Good engineering practice dictates that any such presentation contain a scale. The colors of the pixels, presumably representing locations where the measurements were taken are such that an evaluation of the bins presented is nearly impossible. Note, for example that blue/green (perhaps two different shades) is utilized to indicate signal strengths from 0 dBm to -75 dBm as well as -75 dBm to -85 dBm. Similar colors of yellow/orange are used to indicate two other bins of signal strength. Ideally the bin below the first one would have been depicted in a quite contrasting color, say green to red, then blue, or violet. This way an engineer attempting to determine exactly where any alleged gaps or inferior signal strengths are would quite easily be able to determine such. . Finally the bin size is too large. Note that a 3 dB difference is equivalent to twice as much power and a 5 dB difference is equal to over a three times as much power. There is no measurement protocol depicted to make these measurements, that is the measuring equipment and its accuracy. Therefore any such "hard" limits are incorrect because of uncertainty. 2 dB bins would be more appropriate for determining, once again, if a gap exists or the signal is inferior, and while one could use bins of different size, it is particularly important that the bins provide meaningful information in the ranges that distinguish areas with acceptable coverage from those that which is not.

For example, if a -95 dBm signal is acceptable, it is important to have bin sizes that allow a reviewer to distinguish between areas where signals are slightly below and slightly above those levels, and those where the signals are well within the levels. This allows the reviewer to observe the signals patterns, and discern whether claimed coverage gaps are meaningful. It is also curious that only 2100 MHz is presented. The coverage from 2100 MHz is inferior to the 1900 MHz and significantly less robust that the 700 MHz frequency that Verizon Wireless utilizes in the city.

However, based on the color coding to the extent it is interpretable, the testing appears to show coverage even at 2100 MHz in substantial portions on the Western side of the City, and some 2100 MHz coverage on the Eastern side that would fall within typical network standards for Verizon Wireless for areas of this type. I quote statements from Verizon Wireless describing its network standards below.

Mr. Sharpe presents on page 11 of his Report 1, measured composite coverage at 2100 MHz from all of the proposed nodes. Once again contrasting colors in a critical area of signal strength are not utilized and the map lacks a scale. While these maps are very interesting it remains

impossible for an engineer to determine if there are more nodes than necessary and if the nodes are properly placed.

However, based on the color coding, it appears that the coverage would exceed (that is, produce a signal stronger than) that required under typical network standards for Verizon Wireless, which may imply that there are mote sites than necessary (although I cannot determine how many more than necessary there are based on the information available).

Report 3 presents the results of actual continuous wave ("CW") drive tests performed by Crown Castle of its proposed nodes. Such a protocol can be invaluable in determining not only the depth of coverage provided by a node, but also the breadth as well. Curiously, while suffering the flaws in Mr. Sharpe's maps. i.e. lack of contrasting colors and a scale, the pixels representing measured coverage are not continuous and do not seem to actually follow the roads. While there is a modest explanation on the measurement protocol, the results do not depict, in this engineer's opinion the actual coverage of each individual node so as to determine if there are more nodes than necessary. Please also note that the so called "link budget" contains a significant amount of head room (a safety factor that takes into account such conditions as fading, body loss, building penetration) which could indicate significantly less coverage than actually exists. It is difficult for this engineer to provide a critical opinion on these presentations.

The city did request additional information on the coverage that Verizon Wireless now provides to the city from not only its 2100 MHz system, but its 1900 MHz and 700 MHz systems as well. The assumption is that these systems should provide even greater coverage than the 2100 MHz system. Mr. Aljibori's Report 2 is intended to provide a response to the coverage provided by the other systems.

The sites indicated on Mr. Aljibori's Exhibit 1 have been identified and examined on Bing Maps site with the feature noted as "birds eye." This helps in identifying the existing macro sites as to height above ground and antenna configuration. Exhibit 2 in the Report 2 shows calculated coverage from the reported sounding Verizon Wireless sites. Mr Aljibori utilizes the propagation tool ATOLL to present the calculated coverage.[3] The first map is of 700 Mhz calculated 700 MHz coverage. This presentation is curious as it appears to be "tailored" specifically to the corporate boundaries of Rye. One can only wonder if the coverage over the water to what, for lack of a better name, be the "peninsula" in the south east corner of the city. Is the observer to believe that the coverage stops at the city limits? In addition, while it is obvious that coverage is being provided by the site known as "Harrison and Gleason Avenues, Harrison, where is any coverage from the existing macro site at 244 Halstead Avenue in Harrison?[4]

More importantly in this propagation map is the lack of calculated signal strength less than -95 dBm. In the numerous applications that this engineer has reviewed for new Verizon Wireless

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[3] Notwithstanding that claim, the propagation results do not seem to agree with the countless ATOLL propagation maps this engineer has reviewed with respect to presentation. For example, please note all of the "noise" that is present in the coverage. Supposedly, indicating poor coverage. Perhaps this is a result of the copy of the map that was supplied and it can be taken as such.

[4] By way of Bing Maps, that appears to be an apartment house of 6 or 7 stories. It may indeed provide such coverage.

facilities, in the coverage justification it clearly states: *Verizon Wireless' network standard for reliable 4G LTE wireless service for highway and rural settings is -105 dBm RSRP. Network reliability and environments outside (or weaker than) the -105 dBm RSRP coverage boundary (represented as in the white space as provided coverage plots). Similarly, and as described above, -95 dBm RSRP is used in areas where additional signal strength is needed to penetrate into buildings (e.g. city centers, dense residential, commercial and industrial type environs).* While I have not specifically examined population densities, this engineer as a result of his work in this area is familiar with the terrain and the basic characteristics of this area. It would appear that signal strength up to and including -105 dBm would be sufficient to provide reliable service to this relatively flat, terrain less suburban area to the South and East of the center City, as it had few commercial or industrial environs (other than the club areas). It is indeed unfortunate that such calculated plots indicating -105 dBm were not presented. Notwithstanding all of the above noted issues, it still remains where is the coverage from 1900 MHz?[5]

Exhibit 3 of Mr. Aljiburi's report overlays existing calculated 700 MHz coverage over the proposed nodes. Notwithstanding the lack of information regarding calculated signal strength below -95 dBm, there appear to be significant areas without Verizon Wireless coverage. For this review please note what has been referred to as the "peninsula" to the south and east of city center. Note that this area, along with an area to the north and west *appear* not to be covered with -95 dBm coverage. As a result of the noted "truncated" coverage to city boundaries, it is not clear that this area is not served by -95 dBm let alone -105 dBm.

Exhibit 4 of Mr. Aljibori's report is intended to indicate the capacity (or the limitation of capacity) of existing sites providing coverage to the city. It is curious to this engineer that in the first frame of Exhibit 4 the adjacent sites are indicated. Note for example that a site just to the west of the city (it appears to be 244 Halstead Avenue) is indicated in the Exhibit as site 5 Alpha Sector. This is curious as the coverage maps of the previous Exhibit do not show coverage from this site and even more curious, by Verizon convention, the alpha site typically points to the north east, not south east, where one might expect coverage. The beta site (by convention south east) indicates coverage that may never be exhausted. Another issue associated with all of the capacity profiles are that exactly what system id this depicting? Is it 700, 1900 or 2100 MHz? There appears to be no support for exactly what system is being depicted.

The FDV ("Forward Data Volume") numbers of the sites is also curious. FDV is a metric of how fast (or what is the capacity of a site) to provide down load speeds to subscribers. In many of the FDV presentations it is seen as peak usage (typically the so called busy hour) on each sector. The typical straight line that starts somewhere in the middle of the data is at some slope which seems to vary from site to site. Typically such plots will include more than just a variable slope line. Verizon Wireless applications this engineer has reviewed show FDV data, but include a significant greater amount of information. Specifically, besides that variable slope line Verizon Wireless indicates the capacity line (shown here, but not defined as to the differences between sites), the actual usage, the normalized usage, the smoothing line, the discontinuity line as well as the trend line, none of which are present here, but which permit a better assessment of

[5] As will be noted below, this is an important issue associated with the capacity justification presented by Verizon Wireless

as well as the trend line, none of which are present here, but which permit a better assessment of the data. Notwithstanding all of this traffic submission, it is unclear exactly what frequencies are purported to be overloaded.

Based on the materials presented, it appears the DAS system is justified wholly on the basis of Verizon Wireless' requirements. Neither Crown Castle nor Verizon Wireless supported the placements on any other substantive ground.

FINDINGS: As a result of this critical review of the materials submitted by both Crown Castle and Verizon Wireless in this matter, the undersigned has the following observations, comments and findings with respect to the application before the city.

Both Crown and Verizon Wireless have attempted to demonstrate that there exists gaps in Verizon Wireless' coverage. However because of: (1) flaws in measurement of all systems that Verizon Wireless operates in the area; (2) the use of a signal strength that is significantly stronger than Verizon Wireless itself states in other applications; (3) modification or truncation of calculated coverage provided it is not clear that there may be significant gaps (assuming all systems are operating) in the area of the city. The evidence presented does indicate gaps in coverage, especially in the south eastern portion of the city (the peninsula) and to a lesser extent to the north west and north east, but once again these gaps may be a result of not utilizing appropriate signal strengths for the terrain, land use and other features in the area of indicated gaps in coverage. I express no opinion here as to whether the "gaps" as may exist are significant.

Evidence was presented regarding the capacity of sites serving the areas of the city. The showing, however, were not specific enough to indicate which system might be experiencing capacity issues and if the other systems could handle the usage. Moreover, the FDV presentations themselves lacked sufficient data for a "traffic engineer' to determine if the indicated overloads were significant and not just normal busy hour peaks in usage.

While it appears the nodes proposed are intended to application is to construct a DAS system to serve Verizon Wireless, neither Crown nor Verizon Wireless it has not demonstrated that the proposed nodes are the only alternatives for providing service. Looking at the priority listing under Chapter 196 of the City Code, I note that, among other things, there is a preference for siting wireless facilities on existing tall structures or where there are existing wireless re may be existing wireless telecommunications facilities. or other so called "tall structures" that could serve as either macro cells or small cells. For example, by utilizing satellite imagery it was determined that there is an existing wireless facility on the roof of a building located at 411 Theodore Freund Avenue in the city. The location of this site is almost "test text book" with its spacing from existing sites at 244 Halstead Avenue, 275 North Street and 66 Milton Rd nearly equi-distant and on the regular reuse grid. It does not appear that Crown Castle or Verizon Wireless considered this site, as no propagation maps were supplied demonstrating coverage that might be achieved from this site. Nonetheless, it appears that a facility there would significantly fill in the purported gap in the area in the western portion of the city, and eliminate the need for many of the nodes there. In most of the hearings in which I have been involved, Verizon Wireless would be directed to provide propagation maps from this site (or other similar sites) at appropriate signal strength levels. Moreover other possible sites have been identified for macro

cell deployment. Specifically a quite tall apartment building known as the Hansa Building where a stealth installation would undoubtedly provide a significant amount of coverage to the north west portions of the city as well as relieving any purported traffic insufficiencies on the site located at 66 Milton Rd. in the city. There also appear to be possibilities for a macro site at 788 Harbor House, the Yacht club as well as the city fire house these locations either on or near the peninsula. To the extent that there are deficiencies in service, any of these sites could provide significant coverage relief in an area with many proposed nodes, significantly reducing or eliminating the need for the nodes. While the availability of any of the above mentioned sites is not known to this engineer it would typically appear to be Verizon Wireless' (or Crown Castle's) responsibility to present information to the city regarding the site's availability to locate or co locate a wireless facility.

I should note that I have reviewed an RF analysis that purports to show that coverage goals can be achieved by the placement of a 45-foot structure near Whitby Castle. I do not believe that is likely to the case, and I would not recommend that the City rely on that analysis. Without addressing the analysis in too much detail, it uses a model that tends to be overly optimistic, and is intended to be used for structures at 90 feet or higher. The analysis is of little utility for the sort of structure proposed.

The Crown provided node design appears to be quite thorough, and perhaps somewhat more than is needed, even assuming that a DAS system with facilities in the rights of way is the only alternative for providing coverage in areas where coverage or capacity issues actually exist. It was impossible for this engineer to determine the distance between nodes and , the actual individual coverage from each node and given the deficiencies (identified above) in the test analyses prepared by Crown Castle, but as noted above, the data that is presented does not show that all the nodes are needed. The unfortunate use of colors and bin size prevents an engineer to determine if there may be more nodes than actually needed. In addition the so called "link budget" utilized by Crown in measuring the coverage of each node (notwithstanding that coverage could not be verified because of the form of presentation) provides a significant amount of safety (at least 9 dB) over what might be expected. Such a safety factor tends to reduce the actual real world expected coverage from each node, and thus tends to lead to installation of more nodes than may be needed if a different safety factor were used.

The final finding and opinion of this engineer is that both Crown and Verizon Wireless have failed to demonstrate that there exists gaps, meaningful deficiencies in coverage or data handling where service could not be provided above a level that meets or exceeds its needs or its competitor's systems, network standards that Verizon Wireless uses in similar markets. Likewise, it has not shown that the network standards cannot be satisfied through strategic placement of facilities at alternative sites, or if the number of DAS nodes are reduced. I understand that the City expects to take final action on the request for DAS placement on April 19. If it should choose to deny based on the information before it, The city may very well wish to direct Crown and Verizon Wireless, should it wish to pursue placement of facilities, to provide data supporting its claims that is are based on Verizon Wireless' network requirements and can be verified by independent engineering studies. Verizon Wireless could also be directed to explore the use of possible macro sites or small cell sites that could provide the coverage and

data relief it seeks while possibly minimizing the number of nodes requested in the application based on those alternative, and more typical network requirements.

Very truly yours,

Ronald E. Graiff